



*The Proceedings*  
OF  
THE INSTITUTION OF  
ELECTRICAL ENGINEERS

FOUNDED 1871: INCORPORATED BY ROYAL CHARTER 1921

ISSUED IN THREE PARTS AS FOLLOWS:

Part A. POWER ENGINEERING (*February, April, etc.*)

Part B. RADIO AND ELECTRONIC ENGINEERING (INCLUDING COMMUNICATION ENGINEERING)  
(*January, March, etc.*)

Part C. INSTITUTION MONOGRAPHS (*March and September only*)

PART C  
MONOGRAPHS NOS. 132-186

VOLUME 103, 1956

PUBLISHED BY THE INSTITUTION, SAVOY PLACE, LONDON, W.C.2

# The Institution of Electrical Engineers

FOUNDED 1871

INCORPORATED BY ROYAL CHARTER 1921

PATRON: HER MAJESTY THE QUEEN

COUNCIL 1955-1956

## President

SIR GEORGE H. NELSON, BART.

## Past-Presidents

SIR JAMES SWINBURNE, BART., F.R.S.  
W. H. ECCLES, D.Sc., F.R.S.  
THE RT. HON. THE EARL OF MOUNT EDGCUMBE, T.D.  
J. M. DONALDSON, M.C.  
PROFESSOR E. W. MARCHANT, D.Sc.  
P. V. HUNTER, C.B.E.  
H. T. YOUNG.  
SIR GEORGE LEE, O.B.E., M.C.  
SIR ARTHUR P. M. FLEMING, C.B.E., D.Eng., LL.D.  
J. R. BEARD, C.B.E., M.Sc.  
SIR NOEL ASHBRIDGE, B.Sc.(Eng.).

COLONEL SIR A. STANLEY ANGWIN, K.B.E., D.S.O., M.C.,  
T.D., D.Sc.(Eng.).  
SIR HARRY RAILING, D.Eng.  
P. DUNSHEATH, C.B.E., M.A., D.Sc.(Eng.).  
SIR VINCENT Z. DE FERRANTI, M.C.  
T. G. N. HALDANE, M.A.  
PROFESSOR E. B. MOULLIN, M.A., Sc.D.  
SIR ARCHIBALD J. GILL, B.Sc.(Eng.).  
SIR JOHN HACKING.  
COLONEL B. H. LEESON, C.B.E., T.D.  
SIR HAROLD BISHOP, C.B.E., B.Sc.(Eng.).  
J. ECCLES, C.B.E., B.Sc.

## Vice-Presidents

T. E. GOLDUP, C.B.E.  
S. E. GOODALL, M.Sc.(Eng.).  
WILLIS JACKSON, D.Sc., D.Phil., Dr.Sc.Tech., F.R.S.

SIR HAMISH D. MACLAREN, K.B.E., C.B., D.F.C., LL.D.,  
B.Sc.  
SIR W. GORDON RADLEY, C.B.E., Ph.D.(Eng.).

## Honorary Treasurer

THE RT. HON. THE VISCOUNT FALMOUTH.

## Ordinary Members of Council

PROFESSOR H. E. M. BARLOW, Ph.D., B.Sc.(Eng.).  
J. BENNETT.  
C. M. COCK.  
A. R. COOPER, M.Eng.  
A. T. CRAWFORD, B.Sc.  
B. DONKIN, B.A.  
PROFESSOR J. GREIG, M.Sc., Ph.D.  
F. J. LANE, O.B.E., M.Sc.  
G. S. C. LUCAS, O.B.E.  
D. McDONALD, B.Sc.

C. T. MELLING, C.B.E., M.Sc.Tech.  
H. H. MULLENS, B.Sc.  
W. F. PARKER.  
R. L. SMITH-ROSE, C.B.E., D.Sc., Ph.D.  
G. L. WATES, J.P.  
G. O. WATSON.  
D. B. WELBOURN, M.A.  
J. H. WESTCOTT, B.Sc.(Eng.), Ph.D.  
E. L. E. WHEATCROFT, M.A.  
R. T. B. WYNN, C.B.E., M.A.

## Chairmen and Past-Chairmen of Sections

### Measurement and Control:

W. BAMFORD, B.Sc.

\*M. WHITEHEAD.

### Radio and Telecommunication:

H. STANESBY.

\*C. W. OATLEY, O.B.E., M.A., M.Sc.

### Supply:

L. DRUCQUER.

\*J. D. PEATTIE, C.B.E., B.Sc.

### Utilization:

D. B. HOGG, M.B.E., T.D.

\*J. I. BERNARD, B.Sc.Tech.

## Chairmen and Past-Chairmen of Local Centres

### East Midland Centre:

F. R. C. ROBERTS.

\*J. M. MITCHELL, B.Sc., Ph.D.

### Mersey and North Wales Centre:

PROFESSOR J. M. MEEK, D.Eng.

\*P. R. DUNN, B.Sc.

### North Midland Centre:

F. BARRELL.

\*G. CATON.

### North-Eastern Centre:

A. H. KENYON.

\*G. W. B. MITCHELL, B.A.

### North-Western Centre:

G. V. SADLER.

\*PROFESSOR E. BRADSHAW, M.B.E.,  
M.Sc.Tech., Ph.D.

### Northern Ireland Centre:

MAJOR E. N. CUNLIFFE, B.Sc.Tech.

\*MAJOR P. L. BARKER, B.Sc.

### Western Centre:

T. G. DASH, J.P.

\*A. N. IRENS.

\* Past-Chairman.

### Scottish Centre:

\*E. WILKINSON, Ph.D., B.Eng.

\*J. S. HASTIE, B.Sc.(Eng.).

### South Midland Centre:

H. S. DAVIDSON, T.D.

\*A. R. BLANDFORD.

### Southern Centre:

L. H. FULLER, B.Sc.(Eng.).

\*E. A. LOGAN, M.Sc.

## Secretary

W. K. BRASHER, C.B.E., M.A., M.I.E.E.

## Assistant Secretary

F. C. HARRIS.

## Deputy Secretary

F. JERVIS SMITH, M.I.E.E.

## Editor-in-Chief

G. E. WILLIAMS, B.Sc.(Eng.), M.I.E.E.



# TABLE OF CONTENTS

VOL. 103, Part C

1956

MONOGRAPHS Nos. 132-186

	PAGE		PAGE
The Theory and Design of Coaxial Resistor Mounts for the Frequency Band 0-4000 Mc/s. I. A. Harris (No. 132) ..	1	Attenuation and Permeability of Ferromagnetic Waveguides between 9000 and 9675 Mc/s. J. Allison, B.Sc.(Eng.), Ph.D., and F. A. Benson, M.Eng., Ph.D. (No. 156) ..	205
Second-Order Torque Components in the Schrage Motor operating at Synchronous Speed. I. Thomas, B.Sc. (No. 133) ..	11	The Theory of Third-Harmonic and Zero-Sequence Fields. Prof. G. H. Rawcliffe, M.A., D.Sc., and B. C. McDermott, B.Sc.Tech. (No. 157) ..	212
Steady-State Stability of Synchronous Generators as affected by Regulators and Governors. H. K. Messerle, M.Eng.Sc., B.E.E., and R. W. Bruck, B.Sc., B.E. (No. 134) ..	24	Mutual Heating in Transmitting-Valve Filament Structures. W. J. Pohl, M.Sc. (No. 158) ..	224
Discussion ( <i>communicated</i> ) ..	231	Discussion ( <i>communicated</i> ) on 'A Note on the Surface Loss in a Laminated Pole-Face' (Paper by G. W. Carter) ..	230
The Electric Strength of Transformer Oil. M. E. Zein El-Dine, Ph.D., and H. Tropper, Ph.D. (No. 135) ..	35	Discussion ( <i>communicated</i> ) on 'The Suppression of Switching Transients by a Shunt RC Circuit' (Paper by E. A. Finlay) ..	233
A Short Table of the Laguerre Polynomials. Lucy J. Slater, M.A., Ph.D. (No. 136) ..	46	Discussion ( <i>communicated</i> ) on 'Matrix Methods for the Evaluation of Simultaneous Faults in Three-Phase Systems' (Paper by W. E. Lewis and J. H. Banks) ..	233
Function Generators based on Linear Interpolation with Applications to Analogue Computing. E. G. C. Burt, B.Sc., and O. H. Lange, Dr.rer.nat. (No. 137) ..	51	Relative Dynamic Stability of Large Synchronous Generators. H. K. Messerle, M.Eng.Sc., B.E.E. (No. 159) ..	234
A Resonant-Cavity Torque-Operated Wattmeter for Microwave Power. R. A. Bailey, Ph.D., B.Sc. (No. 138) ..	59	An Experimental Study of Intensity Spectra after Half-Wave Rectification of Signals in Noise. G. E. Fellows, Ph.D., M.Sc., B.A., and D. Middleton, Ph.D., M.A., A.B. (No. 160) ..	243
The Correlation between Decay Time and Amplitude Response. S. Demczynski, Dipl.Ing (No. 139) ..	64	On the Inductance of Iron-Cored Coils. P. Hammond, M.A. (No. 161) ..	249
The Residual Time-Constant of Self-Saturating (Auto-Excited) Transducers. Ulrik Krabbe, Ph.D. (No. 140) ..	71	An Approximate Method for Finding the 'Best Linear Servo-Mechanism'. H. H. Rosenbrock, B.Sc.(Eng.), Ph.D. (No. 162) ..	260
A.C. Controlled Transducers. A. G. Milnes, M.Sc., and T. S. Law, B.Sc. (No. 141) ..	81	Analysis of Linear $n$ -Port Networks. I. Cederbaum (No. 163) ..	267
A Millimetre-Wave Magnetron. J. R. M. Vaughan, B.A. (No. 142) ..	95	The Eddy-Current Anomaly in Electrical Sheet Steel. H. Aspden, Ph.D., B.Sc., Wh.Sc. (No. 164) ..	272
A Reflex Klystron Oscillator for the 8-9mm Band. D. J. Wootton, B.Sc., and A. F. Pearce, Ph.D. (No. 143) ..	104	Magnetic Time-Lag Effects in Solid Steel Cores. H. Aspden, Ph.D., B.Sc., Wh.Sc. (No. 165) ..	279
The Magnetic Screening Effect of Iron Tubes. P. Hammond, M.A. (No. 144) ..	112	Note on the Fourier Coefficients for Chebyshev Patterns. Dr. H. E. Salzer (No. 166) ..	286
The Calculation of the Equivalent Circuit of an Axially Unsymmetrical Waveguide Junction. R. E. Collin, B.Sc., Ph.D., and John Brown, M.A., Ph.D. (No. 145) ..	121	Radiation Patterns of Circumferential Slots on Moderately Large Conducting Cylinders. J. R. Wait, M.A.Sc., Ph.D., and J. Kates, M.A., Ph.D. (No. 167) ..	289
Discrimination of a Synchronized Oscillator against Interfering Tones and Noise. D. G. Tucker, D.Sc., and G. G. Jamieson (No. 146) ..	129	Some Properties of Magnetrons using Spatial-Harmonic Operation. R. G. Robertshaw and W. E. Willshaw, M.B.E., M.Sc.Tech. (No. 168) ..	297
Microwave Propagation in Anisotropic Waveguides. A. E. Karbowiak, Ph.D. (No. 147) ..	139	The Determination of the True Side-Lobe Level of Long Broadside Arrays from Radiation-Pattern Measurements made in the Fresnel Region. R. H. T. Bates, B.Sc.(Eng.), and J. Elliott, M.Sc. (No. 169) ..	307
Junction Admittance between Waveguides of Arbitrary Cross-Sections. E. D. Farmer, B.A. (No. 148) ..	145	Possible Errors of a Particular Wide-Aperture Direction-Finder. W. C. Bain, M.A., B.Sc., Ph.D. (No. 170) ..	313
The Design of Quarter-Wave Matching Layers for Dielectric Surfaces. R. E. Collin, B.Sc., Ph.D., and John Brown, M.A., Ph.D. (No. 149) ..	153	An Audio-Frequency Dynamometer Wattmeter. A. H. M. Arnold, Ph.D., D.Eng., and J. J. Hill, B.Sc. (No. 171) ..	325
Electromagnetic Momentum and Electron Inertia in a Current Circuit. Prof. E. G. Cullwick, O.B.E., M.A., D.Sc., F.R.S.E. (No. 150) ..	159	Resultant Reactive Power of Overhead Lines. A. F. Coventry, B.Sc. (No. 172) ..	334
Interpretation of Wavelength Measurements on Tape Helices. C. P. Allen, B.Sc.(Eng.), and G. M. Clarke, M.A., Ph.D. (No. 151) ..	171	Reluctance of the Teeth of a Slotted Armature. S. Neville, B.Sc.(Eng.) (No. 173) ..	338
An Approximate Theory of the Diffraction of an Electromagnetic Wave by an Aperture in a Plane Screen. R. F. Millar, M.A. (No. 152) ..	177	The Use of the Blackburn A.C. Network Analyser in the Analysis of Power System Faults. J. H. Banks, M.Sc., and K. C. Parton, B.Sc. (No. 174) ..	342
Peak-Voltage Measurements of Standard Impulse Voltage Waves. A. Aked, B.Sc. (No. 153) ..	186	H.F. Bearing Variations on an Adcock Direction-Finder. E. N. Bramley, M.Sc., Ph.D. (No. 175) ..	350
An Introduction to the Analysis of Non-Linear Control Systems with Random Inputs. J. F. Barrett and J. F. Coales, O.B.E., M.A. (No. 154) ..	190		
Some Terminology and Notation in Information Theory. I. J. Good, M.A., Ph.D. (No. 155) ..	200		



	PAGE		PAGE
The Continuous Delay-Line Synthesizer as a System Analogue. J. H. Westcott, B.Sc.(Eng.), Ph.D. (No. 176) .. ..	357	The Use of Ethylene Diamine Tartrate for Piezo-Electric Filter Elements. J. Birch, A. G. Frith, A. C. L. Ferguson, R. H. A. Miles, M.A., B.Sc., and J. F. Werner, B.Sc. (No. 182) ..	420
Properties of a Feedback-System Analogue based on a Discon- tinuous Delay-Line Synthesizer. R. M. F. Houtappel, Dr.Ir. (No. 177) .. ..	367	Laguerre Functions: Tables and Properties. J. W. Head, M.A., and W. Proctor Wilson, C.B.E., B.Sc.(Eng.) (No. 183) ..	428
The Application of the Frequency-Response Method to Electrical Machines. S. K. Sen, B.E., and B. Adkins, M.A. (No. 178) .. ..	378	Magnetic Energy and Electron Inertia in a Superconducting Sphere. Prof. E. G. Cullwick, O.B.E., M.A., D.Sc., (No. 184) .. ..	441
Microwave Measurements with a Lossy Variable Termination. H. M. Altschuler, M.E.E., and Prof. A. A. Oliner, Ph.D. (No. 179) .. ..	392	The Polarization of Very Long Radio Waves reflected from the Ionosphere at Oblique Incidence. W. C. Bain, M.A., B.Sc., Ph.D., and C. B.-I. Glass, B.Sc., Ph.D. (No. 185) ..	447
Some Properties of the Transfer Function of Unbalanced RC Networks. I. Cederbaum (No. 180) .. ..	400	A Study of the Field Distribution at an Axial Focus of a Square Microwave Lens. P. A. Matthews, B.Sc., and Prof. A. L. Cullen, Ph.D. (No. 186) .. ..	449
Integral Control with Torque Limitation. J. C. West, Ph.D., and M. J. Somerville, B.Sc. (No. 181) .. ..	407	Index .. ..	457

CORRIGENDA TO VOL. 103, PART C, 1956

Page 27, eqn. (8), *should read:*

$$F_{Mvt} = \frac{-\Delta v_l}{\Delta v_{fd}}$$

$$= \frac{-A_6(Mp^2 + Dp + A_1 - \frac{A_3A_4}{A_6})}{M\tau'_{dz}p^3 + (M + D\tau'_{dz})p^2 + (D + A_1\tau'_{dz})p + (A_1 - A_2)}$$

Page 34, eqns. (34): In the expression for  $A_4$ ,

$$X_d \text{ should read } X'_d$$

Page 96, eqn. (2) *should read:*

$$V_0 = 2(m/e)(\pi cr_a)^2(\gamma\lambda)^{-2}$$

Page 187, col. 1, second line below Fig. 2: 9.67 Mc/s *should read* 96.7 Mc/s.

Page 187, col. 1, last line of Section 4 and 3rd line of Section 5: 10 Mc/s *should read* 100 Mc/s.

CORRIGENDUM TO VOL. 102, PART C, 1955

Page 271, eqns. (2). The third of these equations *should read:*

$$1/m = j\omega M(k^2 - 1)/k^2$$

*Declaration on Fair Copying.*—Within the terms of the Royal Society's Declaration on Fair Copying, to which The Institution subscribes, material may be copied from issues of the *Proceedings* (prior to 1949, the *Journal*) which are out of print and from which reprints are not available. The terms of the Declaration and particulars of a Photoprint Service afforded by the Science Museum Library, London, are published in the *Journal* from time to time.

*Bibliographical References.*—It is requested that bibliographical reference to an Institution paper should always include the serial number of the paper and the month and year of publication, which will be found at the top right-hand corner of the first page of the paper. This information should precede the reference to the Volume and Part.

*Example.*—SMITH, J.: 'Reflections from the Ionosphere', *Proceedings I.E.E.*, Paper No. 3001 R, December, 1954 (102 B, p. 1234).